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Integrated farm management for sustainable agriculture: Lessons for knowledge exchange and policy

David C. Rose[a,*], William J. Sutherland[b], Andrew P. Barnes[c], Fiona Borthwick[c], Charles Ffoulkes[d], Clare Hall[c,e], Jon M. Moorby[f], Phillipa Nicholas-Davies[f], Susan Twining[d,g], Lynn V. Dicks[h]

[a] School of Environmental Sciences, University of East Anglia, Norwich Research Park, Norwich, NR4 7TJ, UK
[b] Department of Zoology, University of Cambridge, The David Attenborough Building, Pembroke Street, Cambridge, CB2 3QZ, UK
[c] SRUC, Kings Buildings, West Mains Road, Edinburgh, EH9 3JG, UK
[d] RSK ADAS Ltd., Spring Lodge, 172 Chester Road, Helsby, WA6 0AR, UK
[e] Forest Research, Northern Research Station, Roslin, Midlothian, EH25 9SY, UK
[f] Institute of Biological, Environmental and Rural Sciences, Aberystwyth University, Gogerddan, Aberystwyth, SY23 3EE, UK
[g] Country Land & Business Association Limited, 16 Belgrave Square, London, SW1X 8PQ, UK
[h] School of Biological Sciences, University of East Anglia, Norwich Research Park, Norwich, NR4 7TJ, UK

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ABSTRACT

As a response to the environmentally and socially destructive practices of post-war mechanization and intensification, the concept of sustainable agriculture has become prominent in research, policy, and practice. Sustainable agriculture aims to balance the economic, environmental, and social aspects of farming, creating a resilient farming system in the long-term. Over the last few decades, various concepts have been used in research and policy to encourage the adoption of sustainable practices. Within such a congested space, this paper assesses the value of 'integrated farm management' as a concept for the promotion of sustainable agriculture. The concept is the subject of renewed policy interest in England and Wales and it is also being promoted in Europe. Previous research, however, has suggested that integrated farm management may not be well understood or widely practised. There are also criticisms that it can be impractical and poorly differentiated from similar ideas. As such, renewed insights are required into how useful the concept might be for encouraging sustainable agriculture. Using a mixed methods approach, we gathered the views of farmers, farm advisors, and industry representatives about integrated farm management in England and Wales, and interpreted these through a theoretical framework to judge the strength of the concept. Overall, the general principles of Integrated Farm Management were found to be coherent and familiar to most of our respondents. However, the concept performed poorly in terms of its resonance, simplicity of message, differentiation from other similar terms and theoretical utility. We reflect on our findings in the context of other ways to promote sustainable agriculture, drawing out messages for policy and knowledge exchange in England and Wales, as well as elsewhere.

1. Introduction

Since the end of the Second World War, agriculture in the developed world has changed dramatically. A shift towards mechanization, associated with the development of ever-more sophisticated technologies, led to a post-war rise in productivity (Binswanger, 1986). It became increasingly clear from the 1960s, however, that the way in which productivity was enhanced caused degradation to the environment and harmed society. Carson (1962), for example, warned of the devastating consequences of unregulated pesticides on farmland biodiversity, with research noting a particularly severe decline in the populations of specialist farmland birds (Fuller et al., 1995). Research has continued to show the challenges of agricultural intensification, particularly in the areas of biodiversity conservation and the provision of other ecosystem services, such as healthy soils and pollination (Kleijn and Sutherland, 2003; Kremen and Miles, 2012; Pimentel, 2006).

As research and farming communities became aware of the need to balance productivity with environmental and social outcomes, the concept of sustainable agriculture was increasingly promoted. Garibaldi et al. (2017) describe agricultural sustainability as a concept which considers the economic, environmental, and social aspects of farming, while also promoting the resilience and persistence of productive

* Corresponding author.
E-mail address: david.rose@uea.ac.uk (D.C. Rose).

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Table 1
Concepts related to sustainable agriculture (partially from Garibaldi et al., 2017).

Concept	Suggested definition (may vary between sources)
Agroecology	The study of ecological processes, particularly functional biodiversity and their impacts (Garibaldi et al., 2017)
Agroforestry	A strategy of land management that incorporates trees or shrubs into the agricultural landscape (Leakey, 2014)
Conservation tillage	A soil management approach with the aim of limited soil manipulation (Lai, 1989)
Diversified farming	Farms that integrate several crops or animals into the production system (Garibaldi et al., 2017)
Ecological intensification	Emphasises ecological processes that support production, such as nutrient cycling, biotic pest management, and pollination (Garibaldi et al., 2017; Kovács-Hostyánszki et al., 2017)
Integrated Crop Management	A whole farm approach to crop management, balancing profitability, productivity, and the environment (Lançon et al., 2007)
Integrated Farm Management	A whole farm approach that makes use of traditional and modern methods to increase productivity, but limit environmental impact (LEAF, 2017)
Integrated Pest Management	An ecosystem approach to crop protection, in which all available measures are used to hold pest abundances below a threshold of economic damage, with an emphasis on non-chemical practices such as crop rotation, crop variety selection, hygiene, habitat management for natural enemies, biological control and monitoring (http://www.fao.org/agriculture/crops/core-themes/theme/pests/ipm/en/)
Organic farming	A holistic system for enhancing soil fertility, water management, and natural control of crop pests and diseases, usually associated with low-input, small, diverse farms (Garibaldi et al., 2017)
Precision farming	Farming that makes use of information technology to ensure targeted and efficient management (Blackmore, 1994)
Sustainable Intensification	Improving crop yield whilst improving environmental and social conditions (Garibaldi et al., 2017)

farming landscapes. Sustainable agriculture has not been carried out in a prescriptive manner, with a variety of ideas and farming models aimed at the objective of growing more food (for profit) while also providing environmental and social benefits (Garibaldi et al., 2017; Plumecocq et al., 2018; Pretty and Bharucha, 2014). Garibaldi et al. (2017) present a partial list of concepts that have been proposed as a way of achieving agricultural sustainability, and we add to this non-exhaustive list by including others from the wider literature (see Table 1; also Gold, 2007 for a longer list of related terms). Many of these ideas, such as integrated pest management, agroforestry, and organic agriculture are now quite familiar, whilst others, such as precision farming and sustainable intensification, are becoming more common. All of these terms have influenced the policy landscape at a variety of scales, as policy-makers constantly look for the best way of encouraging the adoption of sustainable agriculture in practice.

Within the context of the different concepts of sustainable agriculture, this paper is focused on the potential contribution of integrated farm management (IFM). Although the definition of IFM is contested (El Titi, 1992; Morris and Winter, 1999; Randall and James, 2012; Wibberley, 1995), most would agree it has been promoted as a response to the negative impact of agricultural production on the environment and farming communities, while retaining a focus on the economic viability of the farm (Cook et al., 2009; EISA, 2012). Integrated farm management is supported prominently by the farming organisation Linking Environment and Farming (LEAF), a group that works predominately in the UK, but also increasingly in African countries such as Ghana and Kenya. LEAF (2017) state that integrated farm management involves the use of modern technologies and traditional methods, and encompasses site-specific and continuous improvement across the whole farm. It has been described as a 'third way' between conventional and organic agriculture (Morris and Winter, 1999) with the guiding principles designed to maintain productivity, whilst improving the environment.

The concept is currently supported by various initiatives across Europe. For example, the European Initiative for Sustainable Development in Agriculture (EISA) promotes integrated farming across Europe, describing it as the 'most efficient way to a productive, environmentally friendly and socially responsible agriculture in the EU' (EISA, 2012, 1). Both organisations, LEAF and EISA, use similar diagrams to communicate the concept of IFM, the former including nine components (see appendix 1) with the latter adding an additional three (appendix 1 components plus climate change/air quality, human and social capital, and crop nutrition).

In England, the potential of IFM for sustainable agriculture has been explored by government for over a decade (Defra, 2004; English Nature, 2005; Cook et al., 2009), and was the subject of renewed interest as part of the Department for Environment, Food, and Rural Affairs' (Defra) Sustainable Intensification Platform, which was additionally supported by the Welsh Government. One of the aims of this project was 'to develop an IFM approach by which farmers can implement management practices to improve performance sustainably within the opportunities presented by their sectors and location' (Defra's Sustainable Intensification Platform, 2017). A whole farm, balanced approached was seen by Defra's project to be one way of achieving 'sustainable intensification', defined as improving productivity while enhancing the environment and providing social benefits. IFM is also being promoted in the UK through training schemes offered to farm advisors and farmers (Basis, 2018), and is a requirement for some crop assurance schemes (e.g. LEAF marque).

In light of the strong policy interest in England and Wales, and across other parts of Europe, this paper assesses the attitudes of farmers, farm advisors, and industry groups towards IFM. Policies built around concepts ultimately need to be implemented in practice. If the concept is flawed, however, then policies based on it are likely to fail (Kirby and Krone, 2002). As described above, IFM as a concept through which to encourage sustainable agriculture is competing in a contested space.

Research on integrated farming in its various guises (e.g. integrated farming systems) has been conducted since at least the late 1970s, building on integrated pest management research dating back to the 1920s (Morris and Winter, 1999). However, it took until the late 1990s before the concept started to be disseminated to farming practitioners in a sustained way (Morris and Winter, 1999). Once the idea began to be disseminated to farmers, Morris and Winter (1999) describe how social scientists started to become interested in how it was being communicated and whether/how practitioners were implementing it on-farm.

Previous research has found that IFM has experienced limited uptake in practice in the arable sector in the UK (Cook et al., 2009; Defra, 2009) and further afield, for example in the Netherlands (Proost and Matteson, 1997). Furthermore, research conducted in the last two decades has suggested that it may be poorly understood (Morris and Winter, 1999; Langdon, 2013) poorly differentiated from similar ideas (Morris and Winter, 1999), and may be mismatched to advisor skills (Park et al., 1997). Morris and Winter (1999), for example, asked farmers in the west of England whether they could define 'integrated crop management' and 'integrated livestock management' in an attempt to understand knowledge of integrated farming systems. 41% and 48% of farmers contacted by telephone could not define each concept respectively, while significant doubts were expressed about the financial viability of an integrated system.

There is also very little published research on the understanding and uptake of IFM in non-arable sectors (Langdon, 2013). An analysis based on Farm Business Survey information, a dataset based on surveys

conducted by the government[1] in England, assessed the level of integrated farming uptake in the dairy sector. However, Langdon (2013) note that very few survey respondents responded positively to questions concerning whether IFM had been implemented, although noted that the very few businesses that had practised IFM seemed to perform better than other farm businesses (small sample caution).

In light of this previous research which has suggested that IFM is not well understood, and in the context of relatively few recent social science studies on the topic, we consider that there is a pressing need to understand the contribution that IFM can make to the uptake of sustainable farming across different agricultural sectors, including looking at the role of advisors in this process.

We use a theoretical framework outlined by Gerring (1999), which judges the usefulness of a concept against the following criteria – (1) resonance, (2) familiarity, (3) parsimony or degree of simplicity, (4) coherence, (5) depth, (6) differentiation, (7) field utility, and (8) theoretical utility (see 'Methods'). Using interviews, focus groups, and industry workshops, we interpret our data alongside these criteria to judge how good IFM might be as a concept through which to encourage sustainable agriculture in practice. We reflect on our findings in the context of other ways of encouraging agricultural sustainability. In drawing out the key messages from our case study in England and Wales, we provide recommendations for policy, focusing particularly what makes a good policy concept for knowledge exchange with farmers.

2. Methods

2.1. Groups of respondents

We were keen to assess attitudes towards IFM across the supply chain. Farmers from different farming sectors across England and Wales were included in the research design, as well as agronomists, business, and environmental advisors. It was important to gather the views of farm advisors because they have been shown to play an important role in the adoption of new ideas, not least because they develop close and trusted relationships with farmers (ADAS, 2012; AIC, 2013; Dampney et al., 2001; Ingram, 2008; Prager and Thomson, 2014; Rose et al., 2018a)[2]. The chance for successful implementation of agricultural policy is enhanced if the advisor community is receptive to the idea. Furthermore, we included industry representatives from the supply chain since we noted that a requirement to practise integrated farming was part of some produce assurance schemes (e.g. LEAF Marque, M&S Field to Fork). Thus, the views of such representatives are also important when considering the usefulness of IFM. Focus groups and interviews were carried out in 2015.

2.2. Focus groups

Five focus groups lasting approximately one hour were held across England and Wales with arable farmers (two groups in Norfolk), arable advisors (agronomists based across East Anglia), dairy farmers (based in East Sussex), and sheep/beef farmers (lowland and upland, in Central Wales). The locations of these focus groups were chosen based on known contacts and also to cover a breadth of farming enterprises and environments.

Focus groups with farmers formed part of existing knowledge exchange activities performed by various organisations - NIAB-TAG for arable farmers, Farming Connect for red meat farmers, and DairyCo for dairy farmers. Our focus groups represented one of the activities in each outreach workshop run by the aforementioned organisations and were always led by the same lead researcher on our project. The arable advisor focus group was held with advisors based at Agrii. Focus groups were primarily used to inform the content of semi-structured interviews, but primary data from the focus group discussions was also used. They were attended by 10–15 participants, and were recorded and transcribed. As part of a wider discussion of sustainable intensification, respondents were asked to discuss the following two questions; 'what do you understand by the term integrated farm management?' and 'do you practise/encourage integrated farm management?'. The discussion between participants was allowed to flow and develop with little intervention from the facilitator.

2.3. Semi-structured interviews

For a more in-depth analysis of attitudes towards IFM, 78 interviews lasting up to an hour were conducted with farmers and advisors across England and Wales (all conducted by same researcher). The sample was drawn from a wider survey undertaken by the Defra and Welsh Government funded Sustainable Intensification Research Platform (see Rose et al., 2016), which had focused on seven study regions across England and Wales, including farmers from six enterprise types (cereals, general cropping, dairy, mixed, lowland livestock, and Less Favoured Area [LFA] livestock)[3]. These study regions were selected to provide a cross-section of agricultural landscapes in England and Wales. From the 243 farmers who responded to this survey, we employed a purposeful sample to target a range of different farming enterprises and farm sizes. Overall, we interviewed 45 of these farmers (14 arable in Norfolk; and 31 with LFA/lowland beef/sheep or dairy enterprises in Devon/ Conwy).

Thirty-three advisors who offered technical, business, or environmental advice within the broad study areas (Wensum in Norfolk, Taw in Devon, and Conwy in Wales) were also interviewed. The sample, incorporating a mixture of both commercial and independent advisors, was formed with assistance from ADAS (agricultural consultancy). The list of advisors was identified through existing contacts known to ADAS consultants, as well as web-based searches to capture other smaller organisations or independent advisors. A shortlist of advisors covering each of the three study areas were contacted and invited to participate

[1] 'The Farm Business Survey (FBS) provides information on the financial, physical and environmental performance of farm businesses in England. Survey results typically give comparisons between groups of businesses' (see https://www.gov.uk/government/collections/farm-business-survey). In the Langdon (2013, 7) analysis, 'data was taken from the Farm Business Survey of England for 2003-2010. Farms were included in the analyses…if they were classified to 'robust' type4 dairy in at least three of these years. 402 farms met this condition, with 87 of these surveyed in all eight years, and 226 providing data in at least five years. Farms were excluded from the analyses if they had less than 20 dairy cows in any year; this avoided including farms that had ceased dairying but remained in the FBS as a different farm type.'

[2] In the UK, there are various advisory groups in addition to individual agronomists, vets, and other types of advisor. In the UK, groups include the Farming Advice Service (England and Scotland), Farming Connect (Wales), Rural Payments and Services (England), The Farming and Wildlife Advisory Group, Organic Research Centre, and many more. Elsewhere in Europe there is the Farm Advisory System, and Teagasc Advisory Services in Ireland. In the USA, there are rural extension services such as the Agency for International Development. It is clear that advisory structures in a particular country must be well understood since they are a crucial component of knowledge exchange with farmers.

[3] The sample for this survey was provided by Defra/Welsh Government, and was stratified to reflect the main farm types in each area. Any Robust Farm Types accounting for less than 10% of the case study area population were excluded. Farms were selected to give good geographical coverage of each area. In addition, to be included in the sample each holding had to meet the criteria of being a 'commercial holding' as well as farming a minimum of 20 ha. A range of farm sizes were included in the sample. Registered holders were sent an opt out letter giving five working days to opt out of being telephoned to be invited to take part in an interview. Overall, 243 farmers responded to the survey and we selected our interviewees from those who agreed to take part in further work.

from each organisation identified. Where the primary contact was not able to attend or was unreachable, others within the organisation were approached to ensure all identified organisations had a fair opportunity to contribute.

Participants were asked whether they had heard of IFM, whether they understood it, and then to define the idea based on their understanding of the concept (appendix 1). After this, they were provided with a diagram and standard definition of IFM from LEAF (see appendix 1) and asked to consider whether the idea was part of their management strategy. Participants stated which aspects they prioritised, and offered their opinions about the idea, also suggesting areas for improvements. These interviews were transcribed in full by a professional transcription service and coded with Atlas.Ti software. Coding was carried out against pre-selected criteria; relevant quotes were selected under the following headings, 'level of awareness', 'understanding of, and reaction to, the term', 'suggestions to improve the concept', and 'which of the nine aspects of IFM were prioritised in management?'. Results were then applied post-hoc to the classification used by Gerring (1999) to measure the usefulness of the concept (see footnote 5). Although quantitative statements are made in the subsequent results section, it is noted that sample sizes were low. Such statements are not used to imply representativeness of views towards IFM in any one group, but rather to explore possible lessons for policies surrounding knowledge exchange in the context of sustainable agriculture.

2.4. Workshops

Three workshops were held as part of the wider Defra project, undertaken between October 2014 and March 2015, with separate workshops held for the arable, dairy, and red meat sectors. Several groups were represented at these workshops, including agronomists/advisors, policy-makers, advisory boards, technology firms, and the food industry. The wide spectrum of attendees allowed us to assess the understanding of IFM across the farming food chain (see appendix 2 for attendees and numbers). As part of a one-day programme, delegates were split into groups of 4–5 people (4 separate groups for arable/red meat, 3 groups for dairy) and were asked by a facilitator to discuss what they understood by the term 'integrated farm management'. Intervention by the facilitator was kept to a minimum with discussion driven by the participants. A rapporteur was elected to capture the key elements of the discussion. All group members were encouraged to provide their definition of IFM and these were recorded by the rapporteur.

2.5. Theoretical framework

The framework of Gerring (1999) provides a useful set of criteria through which to judge how good a concept is. This framework has been cited 423 times[4] in a variety of contexts, including development, politics, and economics.

He outlines eight key factors:

1 Resonance – the extent to which a term is memorable.
2 Familiarity – the extent to which a concept can be made sense of or is intuitively clear.
3 Parsimony or degree of simplicity – whether there is a simple, clear definition, or alternatively multiple possible interpretations.
4 Coherence – the extent to which principles within a concept fit together - arguably the most important factor (Gerring, 1999).
5 Depth – the ability of a concept to 'bundle' characteristics so that many characteristics of an idea can be communicated in one term (efficient communication).
6 Differentiation – the ability to set a concept apart from a different concept, avoiding confusion.
7 Field utility – a concept must fit within a semantic field and thus work alongside different concepts.
8 Theoretical utility – the ability to form testable theories or hypotheses from a concept.

Our data were applied to this theoretical framework post-hoc[5] as a way of judging whether IFM was a good concept through which to encourage sustainable agriculture in practice.

3. Results

3.1. Resonance

Resonance related to whether farmers could recall hearing the term before, but did not test understanding of the concept. Awareness of the concept was lower amongst farmers than advisors, although there were differences between farming enterprises. Upland livestock farmers in LFA areas of Conwy and Taw were generally not aware of the concept, with just four out of nineteen being confident to say that they had heard of it. The main sources of awareness were the farming media and farmer networking events. When asked about IFM in a focus group, LFA farmers reacted to the question with silence as the term was not known.

Awareness of the concept was also low amongst lowland livestock farmers in Conwy and Taw (including dairy). Only four out of twelve farmers in this group were confident that they had heard of the term, with the farming media and Defra guidance booklets being the main source. Of these four farmers, only one could remember what the term meant with confidence. In the dairy farmer focus group, respondents were generally unaware of the concept.

Arable farmers were comparatively more aware of IFM than livestock farmers, including in the two focus groups. In total, eight out of fourteen arable farmers had definitely heard of IFM mainly through crop assurance schemes, Basis training, other farmers, and the farming media. One farmer, for example, stated that they had heard of it and 'had been doing it for several years now. Everything that is in [crop assurance] plans has to be written down.' (arable farmer, Wensum, 51050[6]). Many farmers had 'filled in several integrated farm management questionnaires for crop assurance' (arable farmer, Wensum, 51007). Another reason for the greater awareness of IFM may be because LEAF (who have developed the most well-known IFM framework in the UK) were perceived by the arable focus group participants as being more focused on arable farmers, rather than the livestock sectors.

Arable advisors were aware of the concept of IFM. All respondents said that they had heard of the term (although two were slightly unsure), but there was some confusion over the precise definition (see next section). The most dominant source of knowledge about IFM came from professional training courses (e.g. Basis points), whilst others had learnt about it through ADAS, LEAF, or Defra. The LEAF diagram used in the interview was familiar to respondents because many had been trained with the same framework on training courses (e.g. arable advisor, 5). Many advisors traced the long history of IFM back to the 1980s (e.g. arable advisor, 10).

Livestock advisors were more aware of IFM than farmers, but slightly less aware than their arable advisor counterparts. Twelve out of eighteen livestock advisors had definitely heard of the term before,

[4] Google Scholar (30/10/2018)

[5] (1) Resonance was addressed with data in the 'level of awareness' code, (2) familiarity and (3) simplicity were addressed by data in the 'understanding of, and reaction to, the term' code, as was (4) coherence and (5) depth, although 'suggestions to improve the concept' and 'which of the nine aspects of IFM were prioritised' helped here too. (6) Differentiation and (7) field utility were also addressed by quotes in the 'understanding of, and reaction to, the term' code. Finally, (8) theoretical utility was judged by author expertise.

[6] This number is a means of identifying separate interviewees and follows the numbering system as used in the project.

Table 2
Definitions of IFM provided by workshop attendees *(ticked box means definition was given in specific workshop)*.

Theme	Definition of IFM	Red Meat	Dairy	Arable
Non specific	Never heard of it	✓	✓	✓
	Difficult to define	✓	✓	✓
	An arable thing!	✓	✓	
	Not monoculture			✓
Efficiency, resource management	Efficiency	✓	✓	✓
	Making the most of your resources	✓	✓	✓
	Linking enterprise types and joining resources	✓	✓	
	Integration of supply chain			✓
Knowledge, organisation and planning	Forward planning	✓	✓	✓
	Joined-up thinking	✓	✓	✓
	Best practice			✓
	Resilient management			✓
	Data management system			✓
	Better use of technology		✓	
	Intensification of farmer/farm manager knowledge		✓	
Sustainability, environmental management	Farm-level sustainable intensification	✓		
	Linking productivity and the environment	✓	✓	✓
	Mix of conventional and organic to maximise production		✓	
	Minimising negative trade-offs within farm boundary		✓	

although a further three thought that they probably had, mainly from the farming press, from LEAF, and through research at university or in journals. One advisor thought that it was 'a bit of a buzzword' which you 'hear about in the press' (livestock advisor, 14), whilst another found out about it from 'reading journals and trade documents' (livestock advisor, 1). Livestock advisors generally thought it was more 'arable focused' (livestock advisor, 17) because organisations like LEAF are 'more in the arable sector' (livestock advisor, 12) and there are more crop assurance schemes for arable farmers where IFM is a requirement.

Workshop attendees from across the farming industry (including business, policy, and advisor communities) were asked to define IFM. In a similar vein to the variety of definitions provided by farmers, a range of responses was provided to this question, illustrating the widespread ambiguity about the term. The full list of responses is illustrated in Table 2, and the list does include the comment 'never heard of it!' which was recorded in all sector workshops. Although the answers in Table 2 move beyond resonance (touching also on familiarity and parsimony), the fact that 'never heard of it' was recorded widely in all groups is interesting.

3.2. Familiarity and parsimony

3.2.1. Familiarity

The general idea that farmers should be aware of the links between different aspects of the farm, how they link together, and the consequences of these interactions for productivity and the environment was well-known. Livestock farmers, who were generally unaware of the term IFM, understood the general principles behind it. In fact, all farmers interviewed across all enterprises claimed to practise some elements of IFM, showing that they recognise the management style but not the banner. This is a notable result given the high proportion of livestock farmers who had never heard of the concept.

For example, a lowland livestock farmer (Taw, 10012) said that he had 'always been doing that', while a LFA livestock farmer (Taw, 10027) said that 'we wouldn't necessarily call it that, but most probably that idea is partly what we try to do'. Furthermore, an arable farmer (Wensum, 51011) thought that it was 'engrained in everything we are doing, it just happens in a sense'. Other farmers, who had initially reacted negatively towards the concept, said that 'maybe we do do integrated farm management' (arable farmer, Wensum 52076) once they had been presented with the principles behind it. Overall it was clear that farmers understood the principles, but 'wouldn't necessarily recognise it in those terms' (arable farmer, Wensum, 51003).

All advisors were also generally familiar with the principles behind the concept, and the need to think about how different aspects of the farm linked together. As one livestock advisor (16) argued, their clients would be 'balancing these things all of the time', and hence so would the advisor. As can be seen from the responses of workshop attendees (Table 2), some industry representatives also understood the joined-up mindset of IFM.

3.2.2. Parsimony

Farmers and advisors generally felt that the term IFM made the concept appear more complicated that it actually was. Indeed, the term itself caused defensive reactions from many farmers. For example, a lowland livestock farmer (Taw, 10003) reacted by saying that 'I suspect I do it already, but I don't actually know what you mean by it', whereas a LFA livestock farmer (Conwy, 20020) thought that it sounded 'like a very complicated word'. Others were even less complimentary, saying that it was a 'load of b******s' written down by someone who 'isn't a farmer'' (LFA livestock, Conwy, 20034). Advisors also reflected on whether the over-complicated term actually masked understanding of the main principles:

> 'It's another one of those things that is a buzz phrase that you know, there's lots of jargon, we need to talk in clear language that farmers can relate to. Doesn't need to be a buzz phrase because they don't really understand that. Someone has been paid a fortune to come up with that. If you went to a client and said we need to have some integrated farm management decisions here, you might not be invited back for another day.' (arable advisor, 1)

> 'I don't think they'd use it in their everyday language. But if you sit them down and talked about it, yes they do it.' (livestock advisor, 7)

Thus, from the term itself, respondents did not feel that the principles were communicated in a simple way. There was, however, generally a more positive reaction upon seeing the diagram in the interview, which visualised nine aspects of IFM. After seeing this diagram, for example, all farmers were happy to say that they practised some elements of IFM.

3.3. Coherence and depth

3.3.1. Coherence

Unsurprisingly, prioritised aspects reflected the main objectives of the farm enterprise. Livestock farmers and advisors, for example, prioritised animal husbandry, soil management and fertility (for grazing), and some mentioned pollution by-product management

(slurry), and organisation and planning. As one farmer stated 'animals are top of the list. Then your soil management because if you ain't got the soil management and your grass right, your cattle don't do well' (lowland livestock, Taw, 10012). Arable farmers and advisors tended to prioritise thinking about the links between crop health and protection, soil management, pollution, and organisation and planning. Landscape and nature conservation was also commonly mentioned by respondents.

Overall, water management and energy efficiency were seldom mentioned as priorities, and lack of water was not a significant problem in two of the study areas (Conwy and Taw). Respondents generally considered the aspects in the diagram to be part of good farming practice, and thus felt that they worked together. There was one major exception, however. Amongst all respondent groups, community engagement was highlighted as being superfluous to farm management, and potentially unrelated to the other aspects. A lowland livestock farmer (Taw, 10019) struggled to see how community engagement 'helps the business', and an arable advisor (3) also could not work out 'where community engagement quite fits into all of this'. Many other similar reactions were gained across groups; in fact, if respondents raised a query about the usefulness of an IFM component, it was often about community engagement.

In terms of whether the concept could be coherently encouraged in practice, advisors raised concerns over the breadth of advice given to their clients. Agronomists argued, for example, that they wanted to 'grow the best crops possible' because that is how their 'reputation was enhanced' (arable advisor, 2). As a result, an agronomist's training and skill set was targeted towards getting the best out of crops. Since they were mainly asked to advise on specific areas, arable advisors typically argued that they would 'talk about specific things' (arable advisor, 3) and so the 'overall umbrella' of IFM would not 'figure in the thinking' (arable advisor, 3). Some agronomists argued that giving advice on how aspects of the farm linked together is 'not something that we do' (arable advisor, 1), partially because they were hired to advise on specific things. Similarly, environmental advisors stated that they were only qualified to give environmental advice. Thus, although all advisors felt that they encouraged IFM in general terms, they could rarely offer integrated advice across the nine aspects. The lack of complete IFM knowledge from a single advisor, therefore, meant that one person could not offer holistic advice, echoing the findings of Park et al. (1997).

In a similar vein to arable advisors, livestock advisors argued that they had to encourage an IFM mindset, but could not provide advice on a whole farm approach as an individual. As one advisor stated:

> 'There are some people within the advice community who wouldn't understand parts of it, and would only look at one area of it. And there are some people who wouldn't give advice on one area without understanding the implications on the others. There is a huge range of skills needed for that.' (livestock advisor, 1)

Other livestock advisors agreed, making statements such as 'I don't see how you can be an expert in that and an expert in that' (livestock advisor, 3). Again, since farmers were often paying for a particular piece of specialist advice, advisors would have to build the skills needed to maximise the quality of their specialism. As such, most livestock advisors had only a 'thinnish layer' (livestock advisor, 18) of knowledge of some aspects of IFM.

3.3.2. Depth

Based on our interpretation of IFM from definition and diagrams by LEAF and EISA, the main components would seem to cover economic, environmental, and social aspects of farm management. Yet, the LEAF version of the diagram stresses only nine aspects of integrated farming, as compared to EISA, which adds three further components – climate change/air quality, human and social capital, and crop nutrition.

Across all groups (except lowland livestock farmers who suggested no additions), several respondents suggested that the concept missed out 'profitability'. While IFM is designed to improve productivity, farmers argued that this was useless if production was not profitable. One arable farmer argued that the aspects in the diagram were 'all great but there is little around the financial side and the crop marketing which is what you are in business for' (arable farmer, Wensum, 52076). He went on to argue that if IFM could be better linked to financial benefits, then it would be a more attractive idea. This point was supported by an arable advisor who argued that a 'profitable farm business needs to be around the outside of that diagram because you can't have any of that if the bank pulls the plug on you' (arable advisor, 1). Furthermore, livestock advisors argued that 'most people wouldn't get excited about the whole integrated side of things' unless it related to the 'fundamentals of the business', which includes profitability (livestock advisor, 7). Supporting this view, another livestock advisor suggested that 'there ought to be a big pound sign' in the middle of the diagram so that the monetary benefits of doing IFM are better articulated.

3.4. Differentiation and field utility

Since many farmers were unaware of the concept of IFM and did not use similar terms to label their practice, there was little confusion with other terms (e.g. those in Table 1). One LFA livestock farmer (Conwy, 20031), however, did think that IFM was 'the same thing as sustainable agriculture'.

The most significant confusion surrounding IFM was highlighted by arable advisors, who widely struggled to differentiate it from Integrated Pest Management (IPM). While IPM may be a part of the holistic concept of IFM, they are not the same. For example, IPM has been very clearly defined by the Food and Agriculture Organisation (FAO) of the United Nations (http://www.fao.org/agriculture/crops/core-themes/theme/pests/ipm/en/) and the European Commission (Directive 2009/128/EC). In contrast to the holistic nature of IFM, IPM is entirely focused on one part of the farming system - crop health and protection. Integrated pest management is defined as an 'ecosystem approach to crop production', in which all available measures are used to discourage the development of pest populations, with an emphasis on non-chemical practices such as crop rotation, crop variety selection, hygiene, habitat management for natural enemies and biological control. Chemical pesticides should only be used as a last resort, in response to threshold pest densities identified by monitoring.

When asked about IFM, many arable advisors conflated the concept with IPM. In response to a question about IFM practice, an arable advisor (4) said that 'we have to do that now, under the new directive that has come from Europe, we have to concentrate on integrated farm management, or integrated pest management to be precise.' Others (e.g. arable advisor 7) thought that they were qualified to offer advice on IFM because they had an 'IPM certificate'.

3.5. Theoretical utility

This section is based on our own scientific judgment and treats IFM as a theory (see discussion for caveat). When considering an integrated systemic approach to farm management as a concept, the most basic scientific question is: does the approach improve environmental, social or economic outcomes from a farm, when compared to a farm not following the approach? It is relatively straightforward to define specific outcomes to test, to formulate hypotheses. For example, for an environmental outcome you might state the null hypothesis H_0 : IFM farms do not have more bird species than non-IFM farms, with the alternative hypothesis H_1 that IFM farms have more bird species than non-IFM farms. One can imagine many similar hypotheses for a range of possible measurable outcomes.

For these hypotheses to be testable, it has to be possible to implement IFM on experimental farms, and to retain control farms that are not doing IFM. Here the IFM concept falls down, because, as explained above, a majority of farmers would claim to be doing IFM, or at least

elements of it, already. It is very hard to imagine what a non-IFM farm looks like. It would have to be managed in a way that did not take account of different elements of the business at the same time, which seems unachievable, or extremely artificial. This is in contrast to the 'IPM' concept that was confused with IFM in our study. In this concept, different biological and chemical approaches to controlling pests are combined together (Birch et al., 2011), and used in a hierarchical manner with the least environmentally damaging first. Non-IPM farms are easily defined as those that only employ chemical pest control methods.

4. Discussion

When measured against Gerring's (1999) framework for judging the strength of a concept, IFM performs well in some areas, but poorly in others. Although there were differences between farming types and roles, our respondents generally found IFM to be a *coherent, familiar* concept. In other words, both farmers and advisors recognised the general principles of IFM, namely more sustainable methods of agricultural production by thinking about how different aspects of the farm business link together. Overall, respondents felt that the components within the IFM diagram worked together, with the notable exception of community engagement in many cases, and accounting for the irrelevance of some aspects for specific farm enterprises (e.g. animal husbandry not relevant for an arable enterprise). If we take the claims of farmers at face value, there does appear to be significant implementation of integrated practices across the study areas. The *depth* of the concept was sometimes criticised by participants, many of whom wondered whether profitability should be more obviously associated with IFM. Furthermore, if we compare the commonly used IFM diagram in the UK (the one used by LEAF) with EISA's version, we see that 'climate change' is not highlighted as a key consideration in the former case, nor is 'human and social capital' nor 'crop nutrition'.

The concept of IFM performed poorly against Gerring's (1999) framework in terms of *resonance, parsimony, differentiation/field utility,* and *theoretical utility*. These failings have implications for research and policy on IFM. Clearly, the label 'integrated farm management' was not well-recognised by many farmers, particularly in the livestock sectors, and workshop representatives were not widely aware of it. As illustrated by a number of the quotes, several farmers found the concept to be unnecessarily complicated; in essence, some respondents felt that it was just an overcomplicated name for something that all farmers did without thinking in IFM terms. Advisors had generally heard of the concept, although arable advisors struggled to differentiate it from IPM, which is different. Furthermore, there do not appear to be standard practices, or a set of indicators, associated with IFM, which makes it difficult to judge whether farmers are actually doing it. In its current form, it seems difficult to form testable hypotheses for IFM, which presents challenges to those who seek to monitor its adoption. If IFM is to be interpreted as a set of guiding principles only, this will have implications for monitoring.

In light of these findings, it is important to consider the implications for policy, particularly since integrated farming is the subject of policy attention in England and Wales (through Defra/Welsh Government), and in Europe (through EISA). We discuss four substantive areas – (1) appropriate agricultural policy extension, (2) economic incentives, (3) training advisors, and (4) designating practices and indicators. In our concluding remarks, we also consider whether there are alternative concepts through which to encourage sustainable agriculture. One potentially concerning conclusion from our research is the apparent lack of progress made on adapting the concept of IFM in light of previous recommendations. While some progress has been made, our findings echo many of the same themes as those identified by Park et al. (1997); Morris and Winter (1999); Pacini et al. (2003); Cook et al. (2009), and Langdon (2013), which we now explore in more detail.

4.1. Appropriate agricultural extension

Morris and Winter (1999) and Cook et al. (2009) found limited awareness of integrated farming amongst UK arable farmers. One of the key recommendations of the former paper was to invest in a system of agricultural extension (a system where high-level advice can be communicated to farmers in a more personal way, for example, with farm visits, demonstration events, or tailored information) which communicates the concept clearly and effectively to farmers. Through training exercises, farm advisors have already widely heard of the concept, which suggests that some progress has been made in communicating the idea to this audience (notwithstanding the problems of differentiation).

The fact that, at the time of our fieldwork, IFM is still not widely resonant with many farmers suggests that there are some problems in the chain of communication. This could be due to a number of reasons; firstly, our wider research from this project suggested that many farmers were not regularly using paid professional advice, and it is advisors that are often influential in bringing knowledge of new ideas (see Rose et al., 2016). This was particularly true in the upland livestock sector where it was deemed less cost-effective to use paid professional advice. Thus, in many cases it is immaterial if advisors know about IFM, if those advisors are not regularly engaging with all farmers.

Good dissemination of IFM principles is further complicated if some advisors are confusing it with IPM. Morris and Winter (1999) found semantic confusion between similar terms two decades ago, and thus there appears to have been little progress. This is a concern because Rose et al. (2016), amongst many other studies (e.g. AIC, 2013; Prager and Thomson, 2014; Ingram, 2008; Rose et al., 2018a), have identified advisors as a key trusted source of information for farmers. In fact, they are a key component in the adoption of practices and technologies (Knowler and Bradshaw, 2007; Rahm and Huffman, 1984) if the dissemination is effective, accurate, and appropriate (Agbamu, 1995).

Certainly in England, farmers no longer have the same level of free advice available to them as in the past (Murphy, 2007). This undoubtedly makes it harder for policy ideas to be communicated across the farming community. Other countries who similarly do not support agricultural extension could also reflect on the value offered by advisors, while those countries who do support such activities should try to maintain them.

It is also important to support other ways in which farmers learn about new ideas. Usually, concepts are best communicated in a face-to-face fashion as this builds trust (Rose et al., 2018b). In addition to the role of trusted advisors, peer-to-peer knowledge exchange makes the most of face-to-face discussion. Many studies have found that peer-to-peer learning is often the best way for farmers to discover and try out new innovations (see review by Rose et al., 2018c). Many of these spaces already exist, either formally through farmer clusters or demonstration test catchments (England – similar versions elsewhere), or informally as farmers network and socialise at markets, in the pub, and in other social spaces. Studies have also shown that knowledge exchange is most effective when there is two-way dialogue, and where there is co-design of concepts (e.g. Moschitz et al., 2015). The experience of IFM, which is not widely resonant across farming businesses, suggests that policy concepts would be best designed in a bottom-up, participatory fashion, instead of conducting knowledge transfer after policy-makers have already determined what the concept looks like.

This would be antithetical to the commonly adopted approach of developing policy concepts and then consulting users at a later stage. As Macmillan (2018) argues, while farmers, advisors, and other agricultural practitioners generally take part in policy-making at some point, this often occurs at the implementation phase, once the policy itself has been shaped. But, as argued by many articles in the academic and grey literature, upstream, sustained, and equitable stakeholder engagement in producing policy is important, sometimes known as co-production or co-design (Barrett and Rose, 2018). Such articles suggest

a number of common factors of successful co-design, including early, sustained engagement, the inclusion of all relevant stakeholders, reflexivity on the part of policy-makers, the provision of suitable time and resources to support engagement, mutual trust and the use of knowledge brokers, and the encouragement of peer-to-peer knowledge exchange (see Barrett and Rose, 2018). In the UK and Ireland, for example, there are research initiatives underway that seek to co-design knowledge with farmers and advisors (see Barrett and Rose, 2018).

Thus in policy, we might re-think agricultural extension as a process that starts with farmers or advisors, rather than with policy-makers, and one which involves all relevant end users (Klerkx and Proctor, 2013; Leeuwis, 2004; Parker and Sinclair, 2001; Rose et al., 2018b). This also means including industry representatives from across the supply chain. Bottom-up co-design of concepts, particularly of the language used, might prevent a significant issue that our research highlighted. Several advisors quoted here argued that they would not use IFM as a concept when talking to farmers, since it was not part of their client's everyday language. This may suggest that knowledge exchange activities have not always listened to practitioner communities in an effort to communicate the concept in more familiar language.

4.2. Economic incentives

One of Morris and Winter's (1999) other key recommendations was to provide economic incentives for practising integrated farming. In one sense, economic incentives related to certification schemes do exist (e.g. LEAF marque and organic certification), and these allow farmers to charge a premium for their products. Such schemes, however, tend not to be as widely applicable outside of the arable and horticultural sectors, and the fact that workshop representatives from across the supply chain were unsure about IFM suggests that there is not currently wider industry support. Involving these industry representatives is important in building the business case for IFM.

One recommendation made by our respondents was to prioritise profitability within the concept of IFM, a suggestion made by respondents to previous research (Morris and Winter, 1999; Langdon, 2013). Some farmers in our study suggested adding a large pound sign in the middle of the IFM diagram, whilst other farmers and advisors said that integrated farming could only be practised if the farm was making money. The contribution of some aspects of IFM, particularly 'community engagement', was doubted by respondents. Such feedback suggests that IFM would be more resonant if profitability was more central to knowledge exchange activities. This recommendation is equally applicable to integrated farming elsewhere, including the work of EISA. Their version of the IFM diagram, and working definition, similarly does not highlight profitability in a prominent way. It is feasible that a better economic case could be made for IFM. To do this, however, would require controlled experiments to isolate the impacts of making improvements in various aspects of IFM, such as community engagement, and/or in determining the impact of joining IFM-based market schemes on a farmer's bottom line.

4.3. Training advisors

In the UK, current agricultural advisory systems tend to be specialist; in other words, advisors will generally offer specialist advice tailored to one particular aspect of the farm, perhaps crop health, animal husbandry, or landscape and nature conservation. Although advisors do consider the effects of their advice on other aspects of the farm business, our findings suggest that there is a lack of truly integrated advice being provided to farmers. A similar conclusion was reached by Park et al. (1997) over twenty years ago. Since we know that farmers are generally not able to pay for multiple advisors, it is not practical to think that integrated advice will result from the amalgamation of individual expertise. While IFM does seem to be part of the training of many current advisors, one recommendation is to ensure that advisors are encouraged to gain the skills and experience needed to think and communicate in an integrated way.

4.4. Designating practices and indicators

Monitoring the uptake and impact of policy ideas is important, otherwise little knowledge is gained about whether practice is improving. If IFM is to be used as a concept through which to encourage sustainable agriculture, researchers, industry members, and policy-makers need to know whether it is making a difference on the ground. A similar point has been made by Dicks et al. (2018) about the related concept of 'sustainable intensification'. The authors argue that much research on sustainable intensification has concerned itself with concept definition, rather than developing practices for how to do it. In identifying a series of practices through which to achieve sustainable intensification, Dicks et al. (2018) take a step towards operationalising the concept. It is now possible to investigate whether farmers are adopting these practices, and to monitor their impacts on productivity, the environment, and agricultural society. For IFM, however, we have raised concerns over its theoretical utility and whether it can be operationalised in a way that means the uptake of standard practices can be monitored. It may be possible to identify a list of such practices, and this should be a priority for those interested in promoting IFM. If it is to be promoted more as a set of guiding principles, then it may not be possible to monitor implementation robustly.

5. Concluding remarks: would other concepts be better for sustainable agriculture?

Throughout this article, we have not directly addressed the question of whether IFM is a useful concept for sustainable agriculture, instead choosing to provide recommendations about how to improve knowledge exchange if it were to attract sustained policy support. Our results, however, suggest that the utility of IFM as a concept for sustainable agriculture could be questioned. In our study, the concept did not resonate well in practice with farmers, while livestock farmers and advisors considered it to be less relevant for them, and arable advisors struggled to differentiate it from IPM. A number of concluding comments can be made.

Firstly, if farmers and advisors generally consider integrated farming to be a core component of good farming practice, then what is the concept of IFM adding? As illustrated by Kirby and Krone (2002), there is a cost associated with pursuing all policy ideas. If a policy idea does not resonate well in practice, and furthermore if it does not necessarily add anything to existing knowledge, then it may be considered superfluous.

This point links well with an important second point. We have illustrated that the conceptual space of sustainable agriculture is congested with many different ideas existing through which to achieve sustainability (Garibaldi et al., 2017). It could be argued that a potentially superfluous concept, such as IFM, adds unnecessary complexity, and seeks to confuse matters further for farmers and advisors by making differentiation harder (although we have no data to make a judgement about whether other concepts are better or worse). If IFM is going to attract sustained policy support in the England, Wales, and elsewhere, then its value should be better articulated. Does the practice of IFM, for example, achieve more tangible benefits than pursuing other ideas such as agroforestry, sustainable intensification, IPM, or sustainable agriculture? A key step in identifying the unique selling point of IFM (if there is one) would be to identify specific practices (if possible), the contribution of which could be measured. Research and policy communities could also consider the direction of travel for sustainable agriculture, considering whether concepts need to be more integrated, or rather certain ones prioritised, in order to limit the problems of lack of differentiation.

Lastly, policy-makers or organisations keen to support IFM should

consider whether it is applicable to all sectors, or rather if it should be targeted towards particular ones (e.g. arable). If it is to be targeted towards multiple agricultural sectors, then the components of IFM, as well as the definition and associated practices, will need to vary between different sectors. Above all, for any concept designed to communicate new management practices to farmers, it would be prudent to consider how projects can be co-designed and led from the bottom-up, making the most of trusted advisor and peer networks.

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Appendix A. Supplementary data

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